

A Work Project, presented as part of the requirements for the Award of a Master Degree in Finance from the NOVA – School of Business and Economics.

# **ACTIVE PORTFOLIO MANAGEMENT USING THE BLACK-LITTERMAN MODEL**

## **Individual report**

Catarina Muacho Anacleto 2452

A Project carried out on the Master in Finance Program, under the supervision of Martijn Boons from Nova SBE and Pedro Frada and Paulo Ribeiro from Caixagest

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## **Theoretical and methodological context**

How to allocate one's wealth in a variety of assets and portfolio optimization are topics widely discussed in literature and crucial for investment banks. Practically applying Markowitz's modern portfolio theory, the traditional Markowitz framework, has many drawbacks- namely stability (the resulting portfolio is very sensitive to input parameters), turnover rates, concentration in a small number of assets, known as corner solutions and portfolio managers aim a more diversified and stable portfolio. Black and Litterman (1992) introduced a framework that mitigates the presented shortcomings and improves the quality of outcome estimates by considering the forward-looking investor's views for the estimation of the expected excess returns.

The goal of this project is to implement the Black-Litterman (BL) model in active portfolio management<sup>1</sup>, where the investor is evaluated relative to a benchmark while maximizing the information ratio – in our case, maximize the active return (alpha) per unit of tracking error. In order to fulfill this purpose, we closely followed the work that was performed by some investment banks that are already using the model to allocate weights to the assets included in a portfolio and the project was also supported and has its basis in many academic papers that study, for instance, the implications, advantages and disadvantages of using BL model under active management.

In a first step, we focused on the estimation of a robust variance-covariance matrix, as it constitutes an important input for the BL model and portfolio theory in general. Different estimation methods were analyzed with the goal of obtaining the best possible forecast. Second, we introduced the initial BL model as it was developed by Black and Litterman with a detailed explanation of all its inputs and mechanisms. As we are working under active management portfolio, a reformulation of the initial model was performed to account for this new environment and a detailed analysis of the results of the model was presented. However, one needs to keep in mind that when it comes to the practical implementation of the BL model, the requirement for subjective judgments makes it difficult to apply in asset management practice as many of the inputs are not fully described in literature and that it is highly dependent on the quality of views. To overcome these issues, a simulation exercise was performed in which the objective is to understand how the model, particularly the weights allocation, reacts when the inputs change and some constraints are added to the initial setting.

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<sup>1</sup> The portfolio and correspondent assets were given to us by Caixagest team

## **Theme developed, diagnostic of the challenge, research, analysis and development of recommendations**

In this project, I was mainly focused on the theoretical and practical part of the implementation of the BL model under an active management setting<sup>2</sup>. The major objective was to understand which reformulations should be done to the initial model presented by Black and Litterman in order to account for the fact that the goal of the investor, under this new framework, is to beat a certain benchmark. Thus, the initial BL framework was focused on maximizing the classical mean-variance problem, that is, maximizing the Sharpe ratio (SR) of a portfolio. However, many investors do not manage their portfolio with that objective in mind; usually it has a benchmark that they wish to outperform, which is the case of Caixagest investors. When outperformance is observed for the active portfolio, the important thing to notice is that the added value in terms of return is aligned with the risks undertaken<sup>3</sup>. Therefore, the goal is to maximize the information ratio (IR) instead of the SR, which means that one wants to maximize the portfolio's alpha (active return), defined as the return of the active portfolio in excess of the benchmark portfolio with respect to a certain level of tracking error (TE)- active risk.

However, as the original BL model was derived with the objective of maximizing a different objective function, some problems appear when one tries to apply the model in active management and it was shown that the IR optimization will lead to active trades even when no views are specified, which should not happen. Hence, a modification on the model was performed in order to solve and account for this issue.

To obtain more intuitive results and more adapted to investors' reality, and to the case of Caixagest investors in particular, I was also responsible for the development of some studies regarding the inclusion of some constraints in the model, namely a long only constraint (no short positions are allowed), a maximum weight for each class of assets included in the portfolio was imposed, a risk constraint (set a target for the TE based in each specific type of investor) and, finally, by the portfolio theory, the sum of the invested weights need to add up to 1 and the sum of the active weights add up to 0 (in this case there are long and short positions based on the views inputted in the model).

Furthermore, I was also responsible for the explanation of another way of specifying views in the BL model: a qualitative way, in which the IR, according to Ang (2014), can be

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<sup>2</sup> Corresponding to section 7 of the group report

<sup>3</sup> This is especially important when performance fees are involved, in the sense that there is an incentive to bet on more risk

reformulated based on his “fundamental law”. The fundamental law has been quite influential in active quantitative portfolio management because it offers a guideline as to how good asset managers should be at forecasting, how many bets they should make, or both to generate alpha. Following an approach introduced by Fusai and Meucci (2003) and adapted to active management by Maggiar (2009), I included one chapter in the report that explains useful risk analysis tools which will help the managers assess the benefits of the model. As views constitute an important input to the model, this risk analysis allows to understand the coherence of the expressed views by the investor and the importance of each view in the total undertaken risk.

Lastly, as the results given by the BL model change according to the chosen inputs and particularly to the views given by the investor, I developed a simulation exercise using VBA in order to have a sense of the sensitivity of the model.

Applying the BL model to a real portfolio of assets that was given to us by Caixagest team came with many challenges. Firstly, the initial model was developed in a non-active setting and applied to a portfolio that only included stocks; on the other hand, in our case the goal was to implement the model under an active environment and to a portfolio that includes a variety of asset classes, such as fixed income, equities or a commodities index.

Secondly, while the combination of equilibrium returns and the views specified by the investor with a certain degree of confidence are viewed as advantages of the BL model, the difficulty of building some of the inputs needed to implement the model can be viewed as a pitfall. As a matter of fact, many existing literatures have discussed that there is no consistent and clear explanation for some input parameters that are essential to the model, limiting its implementation. Furthermore, in the case of some input parameters, there are diverse ways of computing them and some assumptions needed to be done in order to practically implement the model.

Another point that is important to mention is that the model needed to be adapted for the type of Caixagest’s investors and to its investment strategy, which constituted the major challenge in my opinion. Thus, the goal of Caixagest in applying this model to allocate weights to the assets included in a portfolio was to obtain a more diversified portfolio with not much concentration in just a few assets, as one obtains when implementing the traditional Markowitz optimization. Thus, spreading the risk among a wide variety of assets was the main purpose. Having this in mind, many tests regarding the constraints that should be included in the model were performed and I was also focused on the study of which vector of returns should be inputted in the model: the initial ones developed by Black and Litterman or the ones that are obtained with the active reformulation. However, in the end, as using both vectors of returns

have pros and cons, Caixagest should have an essential basis for deciding if this asset allocation method is an appropriate one to suggest to its investors and under which hypothesis it wants to work with.

Regarding the research that was performed to construct a robust variance-covariance matrix with a good forecasting power and to implement the BL model under active management, the main source of information had its basis in published information, namely books regarding portfolio management and Bayesian theory and articles/papers published in journals. Some unpublished documents were also analysed, such as thesis and some works that were developed with the goal of studying the advantages and disadvantages of the model and how it allocates the weights among the assets. Some of the literature used was provided to us by Caixagest and other could be found on internet. Furthermore, Bloomberg terminal was also used in order to collect the data needed and to obtain more information regarding the assets that constituted our portfolio.

In what concerns the active construction of the model, the topic that I developed, articles made by investment banks that are already using the model were studied as some research papers published regarding the adjustments that should be performed in the model were also analysed and some attention was also given to papers that described the intuition behind the results obtained through the implementation of the model and to the constraints that one may include in it. The work developed by authors as He and Litterman (1999), Maggiar (2009) and Silva, Lee and Pornrojngkool (2009) was followed and implemented in the case of the portfolio that we are working with.

Important inputs were also given to us by Caixagest team since they already did some studies using the BL model and performed some tests in the portfolio that was analysed by us.

When including the mentioned constraints in the BL model, it is important to have the notion that some of the assumptions that were present in the original framework no longer hold. Thus, it is important to carefully analyse the results provided by the implementation of the model, namely the active weights that should be taken when views are specified by the investor. The investment manager should carefully study if the deviations from the benchmark are aligned with the views and, because of the restrictions inputted, it is also important to test if the portfolio is moving towards the tangency. It may be also interesting to see how the results change when the inputs regarding the parameters change, for instance the method for the estimation of the confidence matrix or the way of presenting the view matrix (equally or market weighted).

## **Personal reflection**

During this group business project, we decided to go through all the steps of the implementation of the model together, from the creation of the variance-covariance matrix to the inclusion of the active management setting into the original model. Furthermore, we also worked jointly in the collection of the data needed and in analyzing literature while working at Caixagest's office.

However, after all the research and the implementation of the practical part of the project in excel (the tool selected to do the computations and to present the numerical results), the work was split in three parts in order to give to each one of the elements of the group the opportunity to focus and specialize in a specific topic that was studied.

As previously mentioned, my theoretical work was based in the reformulation of the model in order to account for portfolio active management. Furthermore, I also put a lot of effort in the practical/numerical part of the project, meaning that my goal was to build an excel workbook with all the results that we reached while implementing the BL model and as much user friendly as possible, allowing the user to choose many of the inputs that were used in it. Moreover, I was also in charge of the construction of the VBA program in excel so that we could perform the simulation exercise that allowed us to study the sensitivity of the model to the views that were specified by the investor and to the returns that were used in the computation of the weights that one should invest in each asset that composes the portfolio.

It is also important to mention that having regular meetings with the academic advisor (Martijn Boons) and with the Business advisors (Pedro Frada and Paulo Ribeiro) constituted a great source of feedback, in the sense that it allowed us to understand which things we could improve or add to the analysis that we were performing, and also to understand what Caixagest expects from the model.

This practical experience of implementing an investment model to a portfolio of assets used by the asset management company of Caixa Geral Depósitos group, one of the most active Portuguese operators in national and international financial markets, allowed me to understand how portfolios are built in practice and what are the main concerns that one should keep in mind when the weight allocation is performed. Furthermore, I was able to apprehend which problems an investment manager has to face in reality in order to suggest to his investor a portfolio that is aligned with his/her goals in terms of risk, return and sometimes constraints on the weights that can be invested in each asset class. Under the active management, another difficulty that one has to face is the fact that sometimes the benchmark that one is trying to beat

was not built by the same institution/ team, meaning that in some cases, one has to work with a benchmark that is not reasonable or adapted to the policy of the company in question.

The Business Project, focused in solving a real business problem, was also important in the sense that I had the opportunity to gain insight into business life, to understand the steps of constructing a portfolio and build an investment strategy that can be adapted to many types of investors. Furthermore, it was an experience that contributed to my personal development and allowed me to develop my analytical and problem solving abilities, to apply research methods, always paying attention to detail, and get a sense of how a research study is performed in big institutions, in the particular case of CaixaGest. To my professional and personal development, it was also important the role that the business advisors and the academic advisor had during the whole project, always giving suggestions and constructive feedback regarding some procedures that should be implemented, for instance. I learned important values that made me a better person such as learning from mistakes always with an open-minded attitude making an effort to be a better professional.

Being this project an important part of the Master program, it was also crucial to apply the theoretical knowledge gained in some courses, as Asset Management, Investments, Financial model or Econometrics, in practical business problems that probably I will have to face during my professional career. I also had the opportunity to learn process management skills and train social skills and competences, because all the project was done in group. Moreover, working in a team, allowed me to gain consciousness of how important it is to be a supportive and responsive person contributing to a good working environment and a unified group while, at the same time, trying to be creative and innovative. It is important to be open to different ideas and value different perspectives

Finally, I would like to refer that this project was important to do network and an opportunity to learn with the experience of the professionals that I had the pleasure to work with.